

DOCUMENT RESUME

ED 235 035

SE 043 328

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TITLE Clay Pots. Third World Science.
INSTITUTION University Coll. of North Wales, Bangor (United Kingdom). School of Education.
SPONS AGENCY Training Services Agency, London (England).
PUB DATE 82
NOTE 17p.
AVAILABLE FROM The Centre for World Development Education, 128 Buckingham Palace Road, London SW1W 9SH.
PUB TYPE Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Ceramics; Cultural Activities; *Developing Nations; Elementary School Science; Foreign Countries; Intermediate Grades; *Rural Areas; Science Activities; Science Education; *Science Experiments; Secondary Education; *Secondary School Science; *Water
IDENTIFIERS Nigeria; Philippines; *Third World Science Project; United Kingdom

ABSTRACT

This unit, developed by the Third World Science Project, is designed to add a multicultural element to existing science syllabi (for students aged 11-16) in the United Kingdom. The project seeks to develop an appreciation of the: boundless fascination of the natural world; knowledge, skills, and expertise possessed by men/women everywhere; application of knowledge and skills to solve the practical problems of everyday life; impact of modern technology in the world; and the influence of the cultural background on the perception of knowledge, problems, and solutions. The unit consists of three sections. Section 1 is an account of how traditional clay pots are made in Sokoto (Northern Nigeria). Section 2 consists of: an experiment to discover how to keep water cool in porous pots; information on why water stays cooler in porous pots and on how water passes through the walls of these containers; and a discussion of advantages of using clay pots for cooling water, especially in rural areas of developing countries. Section 3 is a discussion of village pottery production in the Philippines. Suggested activities include constructing a Taku Kiln from a dust-bin or oil-drum, simple glazing experiments, and hand-built pottery using coiling or slab techniques. (JN)

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CLAY POTS

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THIRD WORLD SCIENCE

Third World Science seeks to develop an appreciation of:

- 1 The boundless fascination of the natural world
- 2 The knowledge, skills and expertise possessed by men and women everywhere
- 3 The application of knowledge, skills and expertise to solve the practical problems of everyday life
- 4 The impact of modern technology in the third world
- 5 The influence of the cultural background on the perception of knowledge, problems and solutions

The following Units have been designed to fit into existing science syllabuses in the United Kingdom:

CARRYING LOADS ON HEADS: CHARCOAL: CLAY POTS:
DENTAL CARE: DISTILLATION: ENERGY CONVERTORS:
FERMENTATION: HOUSING: IRON SMELTING: METHANE DIGESTORS:
NATURAL DYES: PLANTS AND MEDICINES: SALT: SOAP.

The method of use is not closely prescribed. As resources teachers may use them in different ways though suggestions are offered. Feedback is invited from teachers concerning (a) the use made of the material (b) pupils reactions, if possible in their own words, and (c) suggestions for improvements, additions etc.

Please send feedback, ideas and requests to:

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CLAY POTS

Teacher's Notes

This unit begins with an account of how traditional pots are made in Sokoto, Northern Nigeria. The section of 'Cooling Water', which follows, was contributed by Mr. Trevor Roach, after a period as Volunteer teacher in Ghana. From September 1979 to January 1980 Mr. Roach was engaged as research assistant on this project at the University College of Swansea.

The information on village pottery production in The Philippines was sent to us by Mr. Michael E. Rose - an Assistant Field Officer for V.S.O. Mr. Rose has a background in industrial ceramics and Physics teaching and has taught ceramics and general science to the children of leprosy patients at the local leprosarium. He was able to visit several village potteries and collect the information which is included in this unit. He states that the material was mainly used in the ceramics course, but some of it was useful in the teaching of general scientific principles such as oxidation/reduction, thermal conductors and insulators, convection, density, etc. Mr. Rose confirms that the most important lesson is, that a technique which has been in use for thousands of years can still be the most economically appropriate. We have included illustrations of a Communal Korean Kiln and a Japanese Climbing Kiln from 'A Potter's Book' by Bernard Leach, as they demonstrate the same principle as the Chinese 'split-bamboo kiln', described by Mr. Rose.

Perhaps it would be possible to collaborate with the Pottery Department to introduce some practical work e.g. constructing a Raku Kiln from a dust-bin or oil-drum, simple glazing experiments — (See Science for the 70's Book II pp. 49 - Mee, Boyd and Ritchie), and hand-built pottery using the coiling or slab techniques.

CLAY POTS

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- by Mr. Michael E. Pose - an Assistant Field Officer for V.S.O.	

CLAY POTS

The Potters of Sokoto, Northern Nigeria.

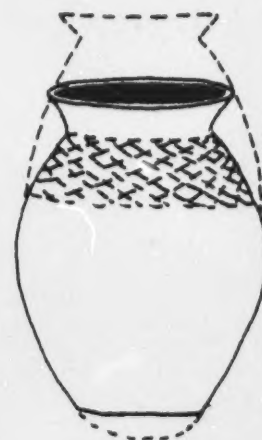
The traditional pots made at Sokoto are part of everyday life, sold at local markets in large numbers. Producing pottery is a community effort - everyone has a job to do. The skills are handed down through families but are not exclusive to any one family. The main production is the Tulu - a large round bottomed pot used by women to carry water (on the head). It is about 1' 6" in diameter and holds about $3\frac{1}{2}$ gallons. A wide mouthed cooking pot (Kwatarni) is made by moulding over the bottom of a tulu and this, with the addition of three legs and air holes, also serves as a hearth. A large jar for water storage (Randa) is also made and for these ground shards are added to the clay instead of chaff.



TULU



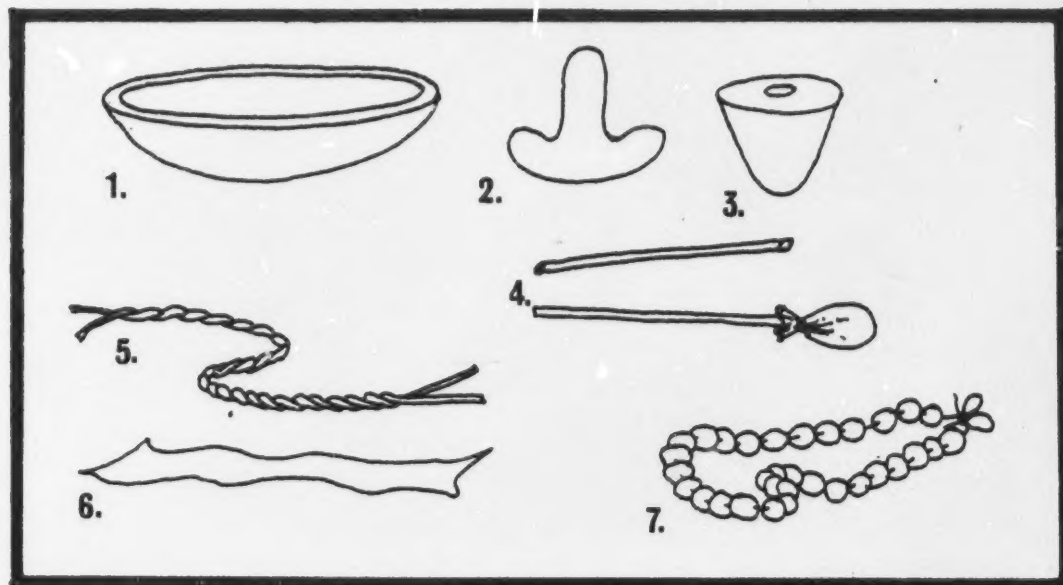
KWATARNE



RANDA

The Tulu is a perfectly symmetrical almost spherical pot. A grey clay, which fires a pale terra cotta, is dug from the river all the year round except during the heavy rains in July and August. It is transported, damp, on donkeys or on the heads of the men and boys. The potters work in round mud huts with thatched roofs, where it is comparatively cool, and the clay is stored inside, wrapped in straw prayer mats. A pile of clay is worked with the feet, mixed with millet chaff. Great care is taken to remove seeds and stones and, by lifting the edge of the mat, the flattened heap is turned, sprinkled with chaff and trodden down over and over again. Water is added as necessary until a soft but unsticky consistency is achieved. A second worker, sitting on the floor of the hut takes a lump of clay and wedges it on his mat, forming a pancake about $1\frac{1}{2}$ " thick and 10" in diameter, dragging out a portion of clay on one side to leave a slight depression.

These are stacked, depression down, in piles. The potter sitting on the floor, uses a shallow 'former' carved out of wood (Talge) - the inside curve is the same as the curve of the final pot. He places the pancake, depression side towards him, into this and turns it once or twice, on edge, anti-clockwise with his right hand and left toe.



1. TALGE - a carved wood or fired clay shape used to form the pot.
2. DUNWUNGE - a smooth stone shape held in the hand to beat the pot from inside against the talge.
3. - a stone shape used to form the lip of the pot.
4. - a long piece of straw and a rag tied to the end of a stick are used to tidy up the inside.
5. - a twisted straw string used to give textured decoration.
6. - a strip of tanned goat skin used for polishing the lip.
7. - a string of beads made from the seeds of the baobab tree used for burnishing.

Ash is sprinkled continually over hands, 'former' and pot to prevent sticking. As it begins to take shape he tips it back and beats the inside against the 'former' with a pestle shaped tool made of stone (Dunwunge) held in his left hand, starting at the bottom centre and moving outwards and upwards. He repeats this three or four times - beating the clay towards the edge. By this means the bottom half of the pot is made, $\frac{1}{2}$ " thick at the bottom and thickening at the outside edge, are then put aside face down to firm. They are then placed outside into the sun, where the temperature is up to at least 43°C at mid-day in April.

SECTION THROUGH KILN SHOWING METHOD
OF STACKING POTTERY. LARGE GAPS ARE LEFT AT
GROUND LEVEL TO TAKE THE STRAW WHICH IS POKED
IN THROUGH THE DRAUGHT HOLES. POTS ARE PACKED
CLOSER AT THE TOP AND FINALLY COVERED WITH
SHARDS.

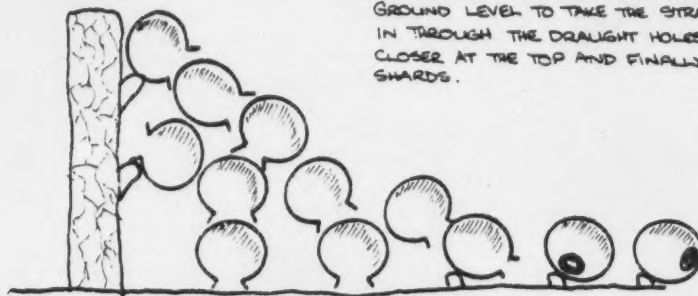
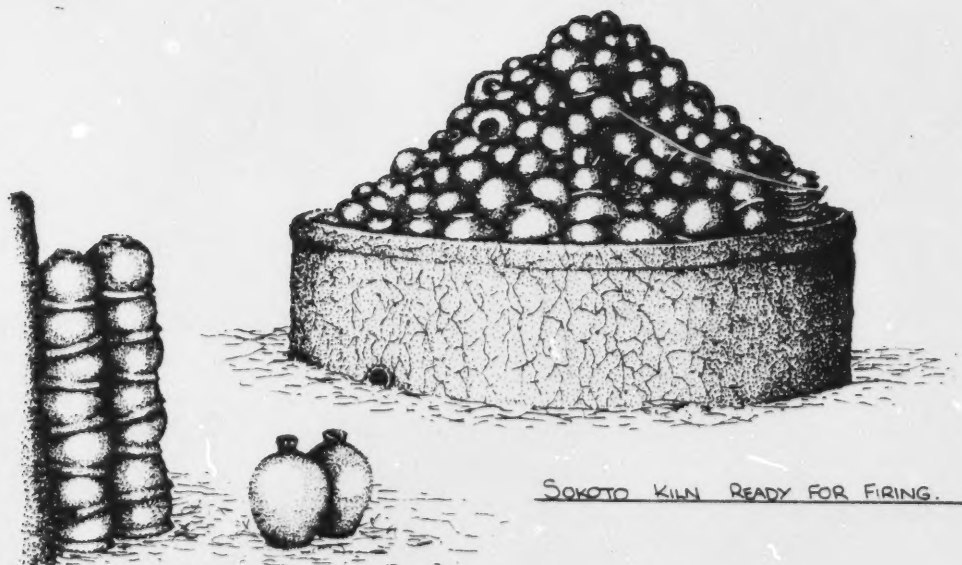
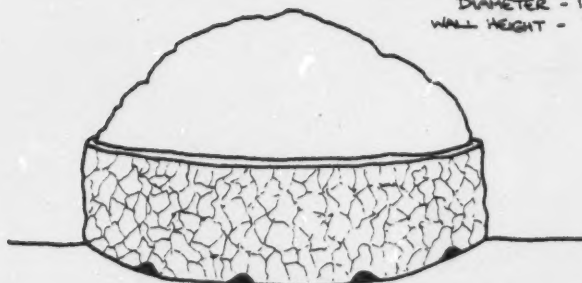


DIAGRAM OF KILN READY FOR FIRING.
DIAMETER - 14 FT.
WALL HEIGHT - 3 FT. AND 6-8 IN. THICK.



SOKOTO KILN READY FOR FIRING.

When the beating and turning process is finished - a 2" hole is left at the top. A piece of wetted leather tied over a rounded lump of dry clay on the end of a stick is inserted into the hole to tidy up the inside and any unevenness pressed out against the mould. The hole is finished with a rounded cone shaped tool made of stone. The pot is then left upright in the sun in a small depression of ash - to become hard.

The next job is to form the lip and a decorative texture can be added by rolling a piece of twisted string round the upper surface of the pot. After this a piece of leather soaked in thick slip made from local red earth (Gargari) is wiped over the lower portion in big sweeping movements as the pot is revolved on a broken shard.

The pots are fired in kilns made of clay, dung and straw - simply a circular wall about 3' high, 14' in diameter. Draught and stoking holes are left at ground level every few feet. The master potter arranges the pots so that air and fire can circulate freely in spaces left at the bottom. The kilns are filled and fired once a week in time for the market. (See drawings).

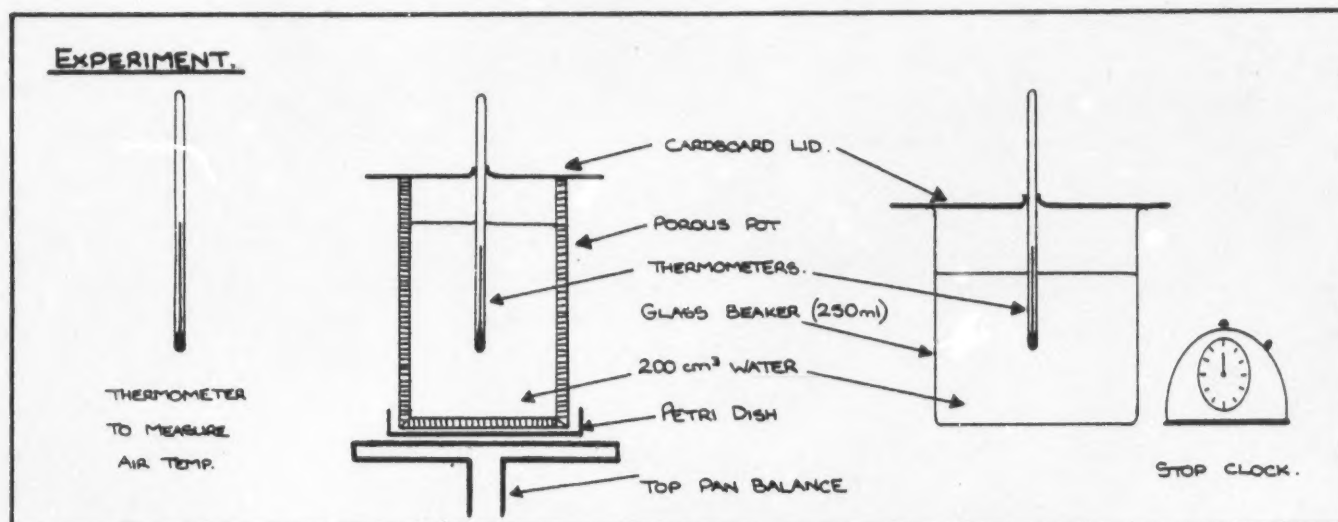
The tulu is a strong and serviceable article. The rounded form means it stacks well and is resilient. Having no glaze the water evaporates just fast enough to stay cool. Well balanced and pouring easily it is a simple and very satisfactory pot. There has been no reason to change it or the method of production based on hundreds of years of experience. The competition of polythene containers or large tin cans suspended on yokes does not seem to have affected its popularity quite yet, and, in spite of ambitious development plans, it will be a long time before piped water is laid on to the houses of all the people of Sokoto State.

Reference

Ceramic Review - July/August 1980 No. 64. The Potters of Sokoto by Jane Whittle.

Cooling Water

In tropical countries the weather is normally very hot and people become thirsty very easily. When people are hot and thirsty it is very refreshing to have a drink of cool water. How can we cool water? Keeping water in a refrigerator is one way, but in order to do this you must first be able to buy a fridge and also you must have an energy supply, such as electricity, available to work the fridge. For many poor people in the world cooling water in fridges is just not possible, so how can they obtain cool water? One way is to store water in porous clay pots. How does storing water in porous clay pots cool water? Carry out the following experiments to try and find the answer.



This experiment should be carried out under a variety of conditions. Both pots can be placed in the shade, in direct sunlight or in windy conditions. Always use both pots together because the glass beaker is the control experiment.

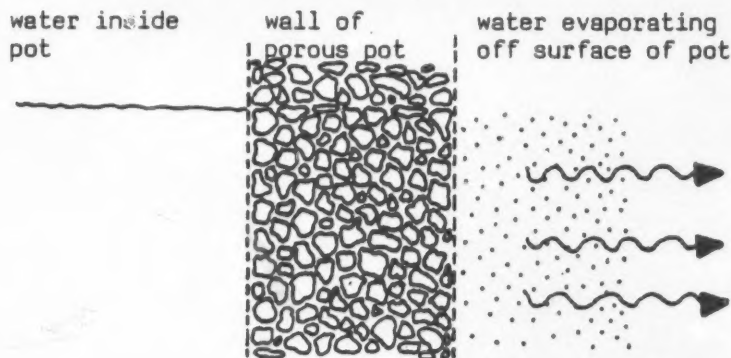
Set up the experiment as shown in the diagram. As soon as you pour in the 200 cm³ of water into each container, record the temperature of the water and the time at which you started the experiment. Also record the weight of the porous pot with the water and thermometer in it. Keep recording the water temperature of both pots and the weight of the porous at regular intervals.

When you do these experiments you should find that the temperature of the water in the porous pot is always lower than the temperature of the water in the glass beaker. Why is this? What did you notice about the weight of the porous pot in each experiment? Calculate the rate of water loss from the porous pot in gm/hour for each of the conditions.

Why Does Water Stay Cooler in Porous Pots?

The walls of the porous pot are made up of large particles which have passages in them through which water can pass, this is why it is called 'porous'. As the water seeps through the walls of the pot it forms a thin film on the outside of the pot, and this film of water is continually evaporating (see diagram)

How Water Passes Through the Walls of a Porous Pot.



When liquids evaporate they take heat from their surroundings and therefore as the film of water evaporates from the surface of the pot the water inside the pot cools down. Try placing a drop of alcohol or acetone on the back of your hand to remind you of this effect.

When the pot is kept in direct sunlight the heat from the sun will tend to heat the water up very quickly. The evaporation rate also speeds up with the increased temperature and so this helps to keep the temperature of the water down.

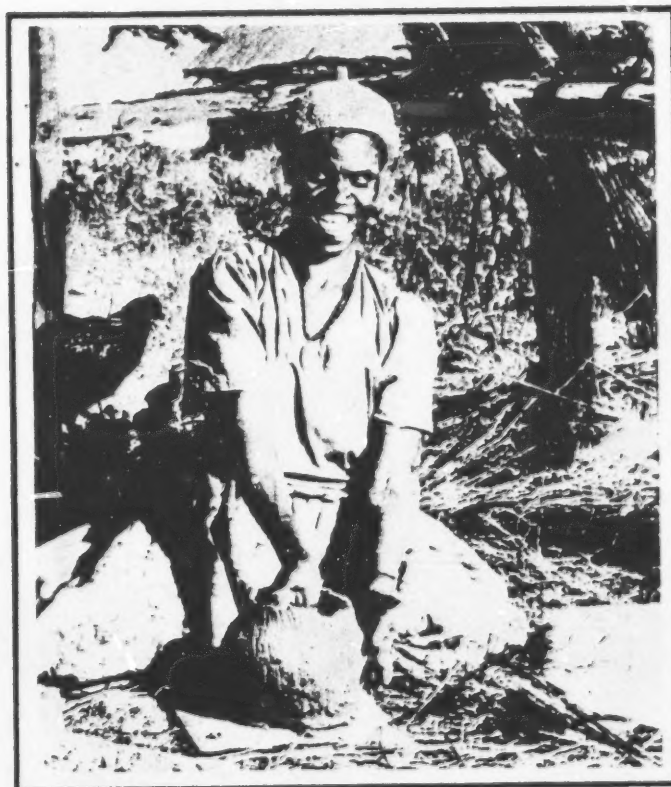
In windy conditions the moist air around the pot is blown away and replaced by drier air, this drier air speeds up evaporation. Therefore windy conditions also help to keep the water cool.

You may have seen water droplets forming on the bottom half of your pot, especially when it was in the shade. This is because the water pressure inside the pot is forcing the water out through the walls faster than the water can evaporate. In a hot country where water may be scarce and people may have to walk a long distance to collect it, to have water leaking out in this way would be a waste. To overcome this problem the bottom half of the pot may sometimes be glazed or smeared with cement so that only the top half of the pot remains porous.



Credit:- I.B. Roach.

- 1.** Women selling cool water from clay pots in a town in Northern Ghana - West Africa.



Credit:- C.W.D.E.

- 2.** Man making clay pots in a village in Zimbabwe - East Africa.

Picture 1. shows some women selling cool water from clay pots at the road side in a town in Northern Ghana, West Africa. The Japanese made car on the left of the picture is a taxi. As you can see from the picture, the tin roof is keeping the pots in the shade. What are the advantages and disadvantages of this? In the north of Ghana in the dry season (November - March) in the early afternoon the temperature can reach 40°C and the air becomes very dry with a relative humidity as low as 10-20%.

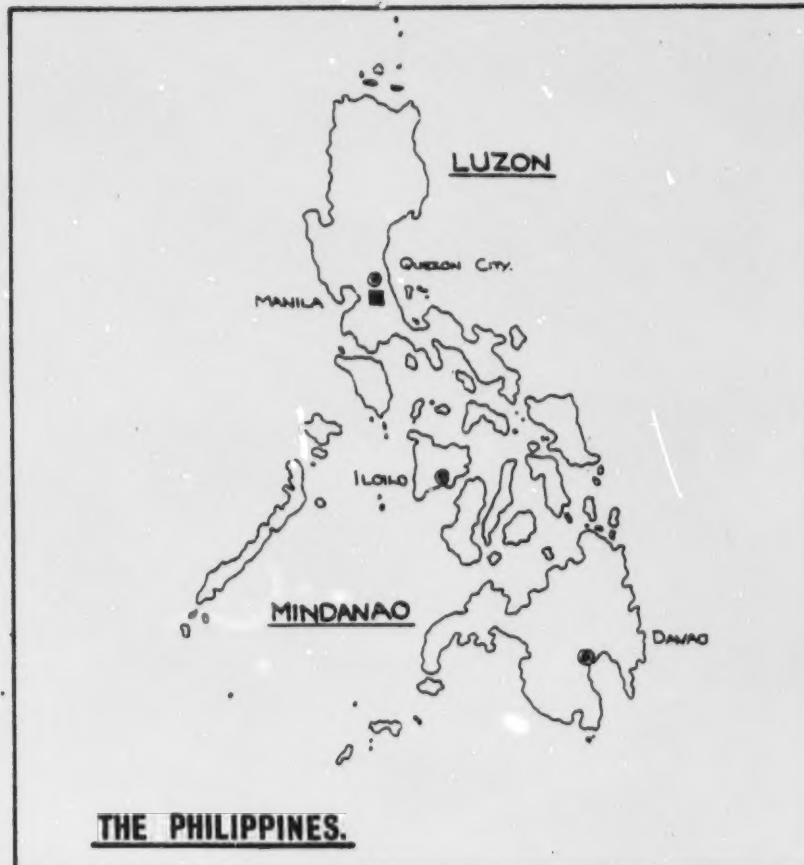
Advantages of using Clay Pots.

It was mentioned earlier that a large proportion of the world's population are too poor to be able to own refrigerators. Even so, the use of clay pots for cooling water has certain advantages over refrigerators, especially in the rural areas of developing countries.

- 1) A clay pot uses local materials for its manufacture, which is clay lying in the ground. This means that they cost very little to make, and a constant supply is available in the villages where they are needed. On the other hand fridges may have to be imported, they may be in short supply and when they break down the spare parts may not be available to repair them.
- 2) Making clay pots requires a skill that people in rural areas in developing countries already have - see picture 2. Therefore the clay pot making industry provides employment for people living in village communities. Try and find out how clay pots are made.
- 3) Clay pots need no energy supply other than the sun to make them work well. This is an important advantage now that the world's energy supplies are becoming more expensive! Rural people living in a hot climate find clay pots the most suitable way of keeping water cool, but if they had the chance they probably would still like to use a fridge. Can you think of the advantages of using a fridge?

VILLAGE POTTERY PRODUCTION IN THE PHILIPPINES

Many areas of the Philippines have large deposits of red clay, formed by the weathering of volcanic rocks such as andesite. The process described below for making cooking pots originated thousands of years ago and is still in use today. They are called 'Palayok' in central Luzon and 'Banga' in the north.



The clay is dug from rice fields before planting begins. It has to be mixed with river sand (not sea sand, since it must be free from salt). The sand helps to control the drying shrinkage of the clay. Mixing is sometimes done by placing clay, water and sand in a pit and allowing a 'caraboa' (Philippine water buffalo) to walk round it.

Cooking pots are made without the use of a potter's wheel. Instead they have a small turntable shaped like a mushroom. The stem of the mushroom sits on a piece of cloth soaked in oil so that it can be turned easily.

The rim of the pot is made first by pinching between forefinger and thumb. The body of the pot is then made by placing a round stone inside and patting the outside with a wooden paddle. The resulting pot is absolutely symmetrical, and the wall-thickness is more like that of bone china than hand-formed ware. Pots made by this method vary in diameter from about six inches to several feet.

The pots are left to dry in the sun, and the surface is then burnished with a shell, to give a smooth surface, and to water-proof it. Sometimes, a fine clay with a high iron oxide content is rubbed into the surface. On firing, the varying oxidation and reduction conditions produce a beautiful mottled black and red appearance. No glaze is used.

The pots are open-fired in a pit filled with rice straw. As the rice straw burns, more fresh straw placed on the top contains the heat, so that a high temperature can be reached.

Despite the simplicity of its manufacture the pot can be used for boiling water for several months before it needs replacement. The cost is about 30p.

When in use the pot is heated on a simple wood-burning stove called a 'Kalan'. This is also made from clay but the clay is mixed with rice husks to make a porous body which is resistant to heat.

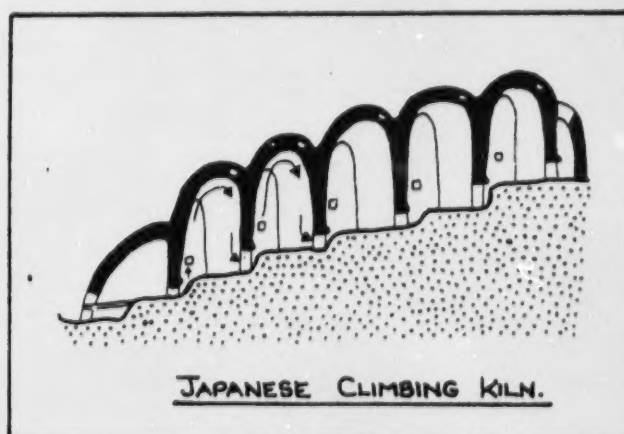
Another local pottery industry is the manufacture of large jars, called 'Tapayan' in central Luzon and 'Burnay' in the north. They can hold more than ten gallons and are used for storing water or vinegar. They are also used for fermentation of local alcoholic drinks such as 'Basi' (made from sugar cane) and in the preparation of 'Bagoong' a salty condiment made from fermented fish or shrimps.

These jars are made in the Iloilo region, where the clay has the property of 'self-glazing'. A glassy sheen on the surface during firing - possibly as a result of the migration of soluble salts to the surface on drying.

A floor level potter's wheel is used to make the jars. The massive wheel is first spun with the foot, and then its momentum keeps it turning for a short time while the thrower works. They are thrown in two halves - an upper and a lower section which are joined with clay slips.



Firing is done in a huge Chinese-style 'split-bamboo' kiln. This is a brick tunnel of semi-circular cross section, some 200 feet long. It is built on an inclined surface, so that no chimney is necessary. The difference in height between the lower and upper ends is sufficient to draw the air through. Wood is used as fuel and this is added continuously through the holes along the side. The kiln is fired very quickly, considering its size. The firing takes little more than a day. (Although the Communal Korean Kiln and Japanese Climbing Kiln are illustrated, they work by the same principles as the Chinese 'split-bamboo' kiln).



Michael E, Rose
 Manila.
 21st November, 1979

ACKNOWLEDGEMENTS

The Third World Science Project has been supported by a number of agencies and has drawn upon the expertise and goodwill of a vast number of individuals.

Pilot Project 1979-80 supported by the Overseas Development Fund

Writers: Trevor Roach, Philip Bladon Typing: Carole Johns
Graphics: George Robinson

Main Project 1981-82 supported by the Manpower Services Commission

Writers: Natalie Jones, Wyn Hughes Typing: Marjorie Eccles
Graphics: Karen Moss

In this phase of the project 100 sets of 14 Units have been produced and distributed to schools, teachers' centres and teacher training establishments. Draft material has been prepared for further Units.

Dissemination 1982-3 supported by the University of Wales

Faculty of Education Research and Publications Fund

Printing: University College of North Wales Print Unit

Distribution: The Centre for World Development Education,
Buckingham Palace Road, London SW1W 9SH

The continued support and encouragement of Mr Dick Meakins of the CWDE is gratefully acknowledged

Sources The ideas and information incorporated in these Units come mainly from science teachers who are, or have been, teaching abroad. In some cases their pupils have also contributed. Some are known to us personally, others only through their letters, articles and books. We are very grateful to them all.

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